

AMENDMENTS TO THE CLAIMS:

This listing of claims will replace all prior versions and listings of claims in the application:

1. (Currently amended) A pattern measuring apparatus comprising:

a storage device ~~which stores~~ to store a plurality of ~~pattern~~ images of a pattern to be measured and predetermined edge reference data, ~~which is used as a reference to detect an edge of the pattern within the pattern images and is configured of the~~ predetermined edge reference data comprising a plurality of pixels that ~~are disposed so as to have an intensity gradient, the pattern images being obtained~~ having been captured by an external imaging device at different focal distances;

a processor to, for each of the images, (i) scan the image, using the predetermined edge reference data, to detect edge points of the image and (ii) output a plurality of correlation values that indicate correlations between the edge reference data and the edge points;

a calculator ~~which scans the pattern image with said edge reference data, detects edge points of the pattern, and also calculates~~ to, for each of the images, calculate a characteristic quantity standardized correlation value that expresses a correlation between said ~~the~~ predetermined edge reference data and the detected edge points of the ~~pattern~~ image, based on the correlation values;

a determinator ~~which determines~~ to, for each of the images, determine an in-focus state ~~that expresses the degree to which the focal position at which each pattern~~

~~image is obtained conforms to a desired pattern edge of the image, based on the calculated characteristic quantity~~ standardized correlation value for the image;

~~an image selector which selects to select one of the pattern image that conforms to measurement of the pattern images from [[a]] the plurality of the pattern images, in accordance with the determined in-focus state of the selected image matching a preselected in-focus state determination result of said in-focus state determinator; and~~

~~a measurer which processes to process the selected pattern image to measure the pattern.~~

2. (Currently amended) The pattern measuring apparatus according to claim 1, wherein said the external imaging device includes an optical system ~~which~~ that is capable of adjusting a focal position thereof within a range defined by an integer multiple of a predetermined step width from a predetermined initial value~~[[;]]~~, and

~~the plurality of the pattern images are pattern images that have been obtained by imaging captured at each of a plurality of focal positions calculated by adding integer multiples of the step width to said the initial value.~~

3. (Currently amended) The pattern measuring apparatus according to claim 1, wherein said the image selector selects a plurality of ~~pattern the~~ the images, ~~in accordance with the determined in-focus states of the selected images matching preselected in-focus states determination results of said in-focus state determinator;~~

~~said the~~ the pattern measuring apparatus further comprises an image processor ~~which performs to perform~~ alignment processing among ~~said the~~ the selected plurality of

~~pattern~~ images and ~~superimposes~~ superimpose in a single coordinate system the edge points of the ~~pattern within the pattern~~ selected images~~[[:]]~~, and

~~said the~~ the measurer measures the pattern on the basis of position coordinates of ~~pattern the~~ edge points that have been ~~superposed~~ superimposed in ~~said the~~ the single coordinate system.

4. (Currently amended) The pattern measuring apparatus according to claim 1, wherein ~~said the~~ the image selector selects a plurality of ~~pattern the~~ the images, in accordance with the ~~determination results of said in-focus state determinator;~~ determined in-focus states of the selected images matching preselected in-focus states,

~~said the~~ the pattern measuring apparatus further comprises an image processor which ~~performs to perform~~ perform alignment processing ~~between said among the~~ among the selected plurality of ~~pattern~~ images and ~~performs perform~~ perform image processing to combine the selected ~~pattern~~ images~~[[:]]~~, and

~~said the~~ the measurer measures the pattern on the basis of the combined ~~pattern~~ images.

5. (Currently amended) The pattern measuring apparatus according to claim 1, wherein only edge points of the ~~pattern which~~ that have been detected ~~from in~~ in previously ~~processed pattern~~ scanned images and ~~which that~~ that are within a predetermined range are scanned with ~~said the~~ the predetermined edge reference data.

6. (Currently amended) The pattern measuring apparatus according to claim 1, wherein the pattern has a plurality of ~~edge lines;~~ edges,

~~said the~~ calculator classifies ~~said the detected~~ edge points ~~that have been~~ detected into an edge point groups group for each of ~~said edge lines~~ the edges, and calculates a characteristic quantity the standardized correlation value for each of ~~said~~ the edge point groups that have been classified~~[[:]],~~ and

~~said the~~ determinator determines the in-focus state of the ~~pattern~~ image for each of ~~said the~~ edge point groups that have been classified.

7. (Currently amended) A pattern measuring apparatus which that is connectable to an external imaging device and ~~which inspects~~ that measures a pattern ~~to be measured~~ on the basis of a ~~pattern~~ an image of the pattern that is supplied from the external imaging device, the external imaging device capturing ~~[[an]]~~ the image of the pattern ~~to be measured~~ with an optical system, a focal position of the optical system being adjustable with respect to the pattern by an integer multiple of a predetermined step width from a predetermined initial value, ~~said the~~ pattern measuring apparatus comprising:

a storage device ~~which stores~~ to store predetermined edge reference data ~~which is used as a reference to detect an edge of the pattern within pattern images and which is configured of~~ comprising a plurality of pixels that ~~are disposed so as to~~ have an intensity gradient;

a processor to, for each of the images, (i) scan the image, using the predetermined edge reference data, to detect edge points of the image and (ii) output a

plurality of correlation values that indicate correlations between the predetermined edge reference data and the edge points;

~~a characteristic quantity calculator which scans each pattern image with said edge reference data, detects edge points of the pattern to be measured, and also calculates to, for each of the images, calculate a characteristic quantity~~ standardized correlation value that expresses a correlation between the ~~detected pattern and said predetermined edge reference data and the detected edge points of the image, based on the correlation values;~~

~~a determinator which determines to, for each of the images, determine an in-focus state that expresses the degree to which the focal position at which each pattern image is obtained conforms to a desired pattern edge of the image, based on said characteristic quantity that has been calculated~~ the standardized correlation value for the image;

~~a measurer which operates to, for each of the images, process the pattern image to measure the pattern, if said the determinator has determined that the focal position at the time of capture of the pattern image conforms to said desired pattern edge in-focus state of the image matches a preselected in-focus state; and~~

~~a focal-position controller which generates to, for each of the images, generate and outputs output control signals to change the focal position of the optical system of the external imaging device, if said the determinator has determined that the focal position at the time of capture of the pattern image does not conform to said desired pattern edge in-focus state of the image does not match the preselected in-focus state.~~

8. (Currently amended) The pattern measurement measuring apparatus according to claim 7, wherein only a predetermined range of edge points of ~~the pattern~~ which ~~that~~ have been detected from in previously processed pattern scanned images are scanned with ~~said~~ the predetermined edge reference data.

9. (Currently amended) The pattern measurement measuring apparatus according to claim 7, wherein the pattern to be measured has a plurality of edge-lines; edges,

~~said characteristic quantity~~ the calculator classifies ~~said~~ the detected edge points that ~~have been detected~~ into an edge point groups group for each of the edge-line edges to calculate ~~said characteristic quantity~~ the standardized correlation value for each of ~~said~~ the edge point groups that have been classified~~[[.]]~~, and

~~said~~ the determinator determines the in-focus state of the ~~pattern-images~~ image for each of ~~said~~ the edge point groups that have been classified.

10. (Currently amended) The pattern measuring apparatus according to claim 7, wherein ~~said characteristic quantity~~ the standardized correlation value is calculated by using a plurality of sets of ~~said~~ predetermined edge reference data.

11. (Currently amended) A method of measuring a pattern ~~to be measured~~ from based on a plurality of pattern images ~~obtained by capturing of~~ the pattern captured by an imaging device at different focal positions, ~~said pattern measuring the~~ method comprising:

detecting edge points of each of the images by scanning the image using predetermined edge reference data that comprises a plurality of pixels having an intensity gradient;

~~detecting edge points of a pattern to be measured by scanning the pattern with edge reference data which is used as a reference to detect edges of the pattern within pattern images and which is configured of a plurality of pixels that are disposed so as to have an intensity gradient, and also calculating, for each of the images, a characteristic quantity which~~ standardized correlation value that expresses a correlation between said the predetermined edge reference data and the pattern, ~~the edge points of which have been detected~~ edge points of the image;

~~determining, for each of the images, an in-focus state that expresses the degree to which the focal position at which each obtained pattern image is obtained conforms to a desired pattern edge of the image, based on said characteristic quantity that has been calculated~~ the standardized correlation value for the image;

~~selecting one of the pattern image which conforms to measurement of the pattern from a plurality of the pattern images, in accordance with~~ images from the plurality of images, the result of determining said in-focus state determined in-focus state of the selected image matching a preselected in-focus state; and

processing the selected ~~pattern~~ image to measure the pattern.

12. (Currently amended) The pattern measurement measuring method according to claim 11, wherein the imaging device includes an optical system ~~which~~ that is capable of adjusting a focal position thereof within a range defined by an integer multiple of a predetermined step width from a predetermined initial value~~[[;]],~~ and the plurality of ~~the pattern images are pattern images that have been obtained by~~ imaging captured at each of a plurality of focal positions calculated by adding integral integer multiples of the step width to ~~said~~ the initial value.

13. (Currently amended) The pattern measuring method according to claim 11, wherein a plurality of pattern the images are selected, ~~in accordance with the result of determining said in-focus state; and~~ determined in-focus states of the selected images matching preselected in-focus states,

~~said~~ the pattern measuring method further comprises aligning among the selected pattern images, ~~said pattern and superimposing the edge points being superimposed of the selected images~~ in a single coordinate system ~~within the pattern images,~~ and

~~the pattern being~~ is measured on the basis of ~~the~~ position coordinates of the superimposed pattern edge points.

14. (Currently amended) The pattern measuring method according to claim 11, wherein a plurality of pattern the images are selected, ~~in accordance with the result of determining said in-focus state; and~~ determined in-focus states of the selected images matching preselected in-focus states,

~~said~~ the pattern measuring method further comprises aligning the selected pattern images and combining the pattern selected images, and the pattern ~~being~~ is measured based on the combined pattern images.

15. (Currently amended) The pattern measuring method according to claim 11, further comprising:

~~scanning, with said~~ using the predetermined edge reference data, only a predetermined range of edge points of ~~the pattern which~~ that have been detected from in previously ~~processed pattern~~ scanned images.

16. (Currently amended) The pattern measuring method according to claim 11, wherein the pattern to be measured has a plurality of ~~edge lines;~~ edges,

~~said~~ the pattern measuring method further comprises classifying ~~said~~ the detected edge points ~~that have been detected~~ into an edge point groups group for each ~~edge line;~~ of the edges,

~~wherein said characteristic quantity~~ the standardized correlation value is calculated for each of ~~said~~ the edge point groups that have been classified~~[[;]],~~ and

the in-focus state of the ~~pattern images~~ image is determined for each of ~~said~~ the edge point groups that have been classified.

17. (Currently amended) The pattern measuring method according to claim 11, wherein ~~said characteristic quantity~~ the standardized correlation value is calculated by using a plurality of sets of ~~said~~ predetermined edge reference data.

18. (Currently amended) A method of measuring a pattern based on an image of ~~[[a]]~~ the pattern to be measured ~~which that is obtained~~ captured by an imaging device, ~~which captures the pattern to be measured and includes~~ the imaging device including an optical system with a focal position thereof being adjustable with respect to the pattern by an integer multiple of a predetermined step width from an initial value, ~~said~~ the method comprising:

detecting edge points of ~~a pattern to be measured~~ the image by scanning ~~[[an]]~~ the image of the pattern with using predetermined edge reference data ~~which is used as a reference to detect the edge points of the pattern and which is configured of that comprises~~ a plurality of pixels ~~that are disposed so as to have~~ having an intensity gradient, ~~and;~~

calculating a ~~characteristic quantity which~~ standardized correlation value that expresses a correlation between ~~said~~ the predetermined edge reference data and the pattern, ~~an edge of which has been detected~~ edge points of the image;

determining an in-focus state ~~that expresses the degree to which the focal position at which each pattern image is obtained conforms to a desired pattern edge of the image,~~ based on ~~said characteristic quantity that has been calculated~~ the standardized correlation value;

processing the image ~~of the pattern~~ to measure the pattern, ~~if it has been determined that the focal position at the time of capture of the pattern image conforms to said desired pattern edge~~ in-focus state matches a preselected in-focus state; and

~~obtaining~~ capturing a new image of the pattern at a different focal positions position, ~~until if it is determined that it conforms to said desired pattern edge by varying~~

~~the focal position of the optical system if it has been determined that the focal position at the time of capture of the pattern image does not conform to said desired pattern edge~~
the in-focus state does not match the preselected in-focus state.

19. (Currently amended) A method of manufacturing a semiconductor device comprising a method of measuring a pattern ~~to be measured from~~ based on a plurality of pattern images of the pattern that are captured and obtained at different focal positions by a pattern an imaging device, said the method of measuring the pattern including comprising:

detecting edge points of a ~~pattern to be measured~~ each of the images by scanning the pattern with image using predetermined edge reference data which is used as a reference to detect edges of the pattern within pattern images and which is configured of that comprises a plurality of pixels that are disposed so as to have having an intensity gradient, and also;

calculating, for each of the images, a characteristic quantity which standardized correlation value that expresses a correlation between said the predetermined edge reference data and the pattern, ~~the edge points of which have been detected~~ detected edge points of the image;

determining, for each of the images, an in-focus state that expresses the degree to which the focal position at which each obtained pattern image is obtained conforms to a desired pattern edge of the image, based on said characteristic quantity that has been calculated the standardized correlation value for the image;

selecting one of the pattern image which conforms to measurement of the pattern
from a plurality of the pattern images, in accordance with images from the plurality of
images, the result of determining said in-focus state determined in-focus state of the
selected image matching a preselected in-focus state; and

processing the selected pattern image to measure the pattern.

20. (Currently amended) A method of manufacturing a semiconductor device comprising a method of measuring a pattern based on an image of ~~[[a]]~~ the pattern to be measured which that is obtained captured by an imaging device, ~~which captures the pattern to be measured and includes the imaging device including~~ an optical system with a focal position thereof being adjustable with respect to the pattern by an integer multiples multiple of a predetermined step width from an initial value, ~~said the method of measuring the pattern including comprising:~~

detecting edge points of ~~a pattern to be measured the image~~ by scanning ~~[[an]] the image of the pattern with using predetermined~~ edge reference data ~~which is used as a reference to detect the edge points of the pattern and which is configured of that comprises~~ a plurality of pixels that are disposed so as to have having an intensity gradient, ~~and;~~

calculating a characteristic quantity which standardized correlation value that expresses a correlation between said the predetermined edge reference data and the pattern, ~~an edge of which has been detected detected edge points of the image;~~

determining an in-focus state ~~that expresses the degree to which the focal position at which each pattern image is obtained conforms to a desired pattern edge of~~

the image, based on ~~said characteristic quantity that has been calculated~~ the
standardized correlation value;

processing the image ~~of the pattern~~ to measure the pattern, if it has been
determined that the ~~focal position at the time of capture of the pattern image conforms~~
~~to said desired pattern edge~~ in-focus state matches a preselected in-focus state; and

~~obtaining~~ capturing a new image ~~of the pattern~~ at a different focal positions
position, ~~until~~ if it is determined that ~~it conforms to said desired pattern edge by varying~~
~~the focal position of the optical system if it has been determined that the focal position at~~
~~the time of capture of the pattern image does not conform to said desired pattern edge~~
the in-focus state does not match the preselected in-focus state.